Fig. 8. is the larva of *Sipunculus* after Max. Müller.
Fig. 9. The larva of an Annelid after Milne-Edwards.
Fig. 10. *Auricularia.* The larva of Holothuria, after Müller; to show the mode of development of the water-vascular system, &c. from the internal bud, *d*: *e*, the oval masses of cells.
Fig. 11. One of the epauletted Echinus-larvæ, in which the Echinoderm, *d*, has already begun to envelope the stomach of the larva.

IX. X. XI. XII. XIII. are diagrams intended to represent the mode of development of an Asterias within its larva the *Bipinnaria*.

The form of the latter is not given; its relation being indicated only by the dotted line.

IX. *m*, the mouth of the larva; *a*, its anus; *d*, the bud-like commencement of the Echinoderm.
X. XI. The latter has developed the water-canals, and with its accompanying blastema has begun to invest the stomach of the larva.
XII. The investment nearly complete. The position of the mouth of the Asterias indicated by (*o*).
XIII. The Echinoderm has become free and separate from the body of the larva with its primitive œsophagus.

It is to be understood that these diagrams do not pretend to be strictly accurate. They are intended only to render the process of development more easily comprehensible.

II.—*Report on* MM. L. R. *and* C. Tulasne's "*Memoir on the History of the Hypogæous Fungi.*" By MM. Jussieu and Ad. Brongniart*.

The mode of vegetation and reproduction of the Fungi had long been one of the most obscure portions of the vegetable kingdom, and, in spite of the progress of this department of botany during the last fifty years, many points yet remain to be cleared up; but in this vast class, the anomalous organization of which has caused some naturalists to regard them as a kind of peculiar kingdom, nothing perhaps is more singular than the development of the subterranean Fungi, the whole life of which, the growth and reproduction, goes on in the bosom of the earth, without any portion of their structure coming to the surface.

This existence, entirely removed from the action of light, is an anomaly even among the plants of the Fungous class, which, generally speaking, prefer weakly illuminated situations; for ordinary Fungi cannot live in complete obscurity without becoming profoundly altered in form and structure, and being kept imperfect and sterile. Light therefore, although in less degree necessary to Fungi than to ordinary vegetables, is almost always indispensable to their regular development at least at the period of reproduction.

For a long period the common Truffle, and a few other equally

* Comptes Rendus, Dec. 30, 1850.

edible species, were the only Fungi in which this unusual mode of existence had been recognized. Thus, at the beginning of this century, Persoon, in his 'Synopsis Fungorum,' described only four species, and in 1822 M. Fries enumerated only twelve species, distributed into four genera.

In 1831 however, the study of the numerous edible species of northern Italy led M. Vittadini of Milan to a more minute examination of these Fungi, and to the investigation of those species of this group which are not available for food; through this, the total number was raised to sixty-three species, arranged in thirty different genera, eight of which were established by this author.

The microscopic examination of these very diversified forms led that able botanist to the recognition of an exceedingly varied organization, the modifications of which threw light, reciprocally, on the obscure and often difficultly comprehensible structure of these Fungi.

But since the anatomical organization, and above all the reproduction of Fungi in general, were at this period enveloped in so much obscurity, the good optical instruments and modes of preparation adapted to microscopic observations of this kind were still confined to so limited a circle, and so far removed from that degree of perfection they have since attained, it is not wonderful that Vittadini, notwithstanding the progress which he caused in this branch of science, left many points to be cleared up and more completely studied.

The important discoveries made a few years later in the different modes of formation of the spores or reproductive bodies of the Fungi with external and superficial fructification, such as the Agarics, the Boleti, the Morels and Pezizas, soon led several botanists to the recognition of these same diverse modes of formation of the spores in the Fungi with internal fructification, the reproductive bodies of which are developed in the cavities of a peridium or common envelope.

Those observations on the common Lycoperdaceæ, which we owe to Messrs. Berkeley, Klotsch, Corda, and in part to Messrs. Tulasne themselves, at once threw light upon the often rather obscure descriptions of M. Vittadini; new examinations demonstrated in fact that the subterraneous Fungi, analogous in their mode of growth to the Truffle, are referable, in accordance with the structure of their reproductive organs, and as Vittadini had already detected, to two essentially different types.

In one type, the *Hymenogastreæ*, the interior of the fleshy mass of which they consist, presents a number of sinuous cavities lined by a membrane analogous to that which clothes the gills of the Agarics, and the superficial cells of which each produce at their

free extremity three or four spores, becoming successively detached, and finally filling the cavities.

The other type, comprising the true Truffles and forming the groups *Tuberaceæ* and *Elaphomyceæ*, also present a fleshy mass, the outer surface of which constitutes the common envelope or peridium, while the numerous narrow, sinuous, not very distinct cavities are lined and in part filled up by a special tissue, mingled with cells of a peculiar form, producing in their interior three or four or from six to eight spores, like the thecæ of the *Pezizeæ*.

Thus in the hypogæous as in the ordinary Fungi, there are two different modes of formation of the spores; in the one class these reproductive bodies are developed upon the external surface of special cells called *basidia* or sporophores; in the other they are formed in the interior of particular cells named *thecæ* or *sporangia*.

This difference in the mode of production of the spores had already been shown by M. Vittadini's observations and figures, although he sought to explain it by an accessory modification of a single kind of organization. It was established in a much more positive manner in different groups of Fungi by various authors of more recent date, by Messrs. Leveillé, Klotsch, Berkeley, and Messrs. Tulasne themselves in various memoirs. It now forms the basis of the divisions both of the hypogæous and of the ordinary Fungi.

But many essential points in the very obscure life of these strange plants still remained to be elucidated.

The discovery of numerous species, the comparison of their form, of their organization, their distribution into well-defined genera, in a word, the natural history properly so called of this curious subterranean flora, has not only resulted in increasing the catalogue of organisms of this kind; these discoveries have, in addition, allowed of a better appreciation being arrived at of their mode of existence, development and reproduction; for this diversity of organization has yielded the solution of questions which would have been very difficult to answer from the study of a small number of species. How many physiological questions have been cleared up in this way by the examination of varied forms of the inferior members of the scale of organization!

The well-directed investigations of Messrs. Tulasne, in the neighbourhood of Paris and in different parts of France, have, in the first place, enabled them to extend the list of these plants greatly; thus, while M. Vittadini, in 1831, indicated only sixty-three species, distributed into thirteen genera, Messrs. Tulasne have carried the number to a hundred and forty-four species comprehended in twenty-five genera, and have added seventy-one of these species to the French flora.

The repeated examination of the structure of many of these plants in different stages of growth, has conducted them to very interesting results, throwing much light upon the life of subterranean Fungi.

It has long been known that in the ordinary Fungi, the fleshy body, of such varied form, commonly considered as forming the whole of the fungus, is only an external development, a temporary product, analogous to certain compound fruits, originating from a filamentous, byssoid, irregular mass extending beneath the surface of the soil or in the interior of the bodies supporting these vegetables, comparable to the subterraneous stems of various plants; this mass, called the *mycelium* or *thallus*, is what, under the name of *Mushroom spawn*, is commonly used for the reproduction of the Mushroom in beds.

All Fungi when carefully examined presented this filamentous mycelium, concealed before the formation and what may be called the expansion of the Fungus; the Truffles however seemed to be devoid of it, and several authors, whose opinions had been hastily received, had supposed that the Truffles were produced directly from the spores of these plants, called by them *truffinelles*, which became increased and dilated in all directions.

Facts observed by Messrs. Tulasne in genera closely allied to the Truffles had already rendered this view, altogether hypothetical, inadmissible. Thus, in *Balsamia*, a genus very close to the true Truffles, Messrs. Tulasne had observed the spores during germination, emitting, like those of other Fungi, delicate ramified filaments, which, by their interlacement, would form the mycelium, destined to reproduce, subsequently, new fleshy bodies, the true fructification of these vegetables. In *Delastria* and *Terfezia*, other genera of this tribe, and better still in the *Elaphomyces*, which are a little removed, this mycelium reproducing the fleshy body which constitutes the Fungus properly so-called, persists for a long time around it, and by its presence proves that these subterraneous Fungi, so near to the Truffles, do not differ in this respect from ordinary Fungi.

It might therefore have been assumed with nearly perfect certainty, that the Truffles proper also possessed a mycelium, producing these fleshy and fungous bodies, but quickly decaying and allowing them to continue to grow in an isolated condition. This has been actually demonstrated, in observations carefully made by M. L. R. Tulasne in the Truffle grounds of Poitou, who has seen the soil in which they grow traversed, in the course of September, by numerous white, cylindrical filaments, much finer than common sowing thread, yet themselves composed of articulated microscopic filaments three to five thousandths of a millimetre in diameter. These white threads are continuous with

a byssoid, flocculent mycelium of the same nature, which envelopes the young Truffles and forms immediately around them a sort of white felt several millimetres thick, the filaments of which are directly continuous with the external layer of the young Truffle, scarcely so large as a nut at this epoch. In a short time the gradual destruction of this byssoid envelope commences; at first a part, then the whole is lost, and the Truffle appears completely isolated in the soil.

Thus, that which was indicated by analogy is confirmed by direct observation, and it is seen that the Truffles, like the other Fungi, are reproduced by spores which give origin to a filamentous mycelium, the source of new Truffles. These facts, important in a scientific point of view, from the uniformity they establish in the mode of existence of the whole of a large class of vegetables, may, like many other scientific discoveries, one day become a source of useful applications.

These singular plants, thus isolated in the midst of the soil at the epoch of their reproduction, without apparent external organs, nevertheless exhibit internally a structure much more complicated than was at first supposed. The observations of M. Vittadini had already indicated the curious arrangement of the black and white veins which traverse the tissue of the Truffles, and these had been mentioned by the earliest observers; but the more varied and more precise investigations of Messrs. Tulasne have shown much more clearly their relations and destination. When young, the Truffles exhibit very irregular sinuous cavities, partly communicating with each other and terminating, sometimes at a single orifice corresponding to a depression or umbilicus on the outside, sometimes at several points of the surface which present no distinguishable character externally. As they advance in age, the partitions which separate the cavities become thickened, the tissue composing their surface is developed into a kind of white tomentum which obliterates them; hence result two systems of veins; one set coloured, corresponding to the partitions which separated the primitive cavities, the other white, formed by the filamentous tissue which finally fills these cavities.

The former are continuous with the external tissue which composes the envelope of the Fungus, or peridium; in their middle portion they are formed of a network of filaments or elongated cells, running in the direction of the cavities; from this arise shorter filaments, almost perpendicular to the first, and the inflated extremities of these become the sporangia, or sporigenous cells; the deep colour is due to the black or brown colour of the spores. The other veins, the white ones, appear to be formed of the prolongations of sterile filaments, intermingled with sporigenous cells, and originate like them from the primitive partitions.

The veins composed of these filaments and the air interposed, owe to this structure their dull white appearance, and opacity when their tissue is examined in thin slices by transparent light, under which circumstance they appear darker than the tissue filled with liquid forming the coloured veins. These aëriferous white veins terminate at the external surface, either at a single point to which all converge, or at several distinct points.

In these plants, therefore, so shapeless and simple in appearance, is formed a double system of veins, or rather of irregular filamentous lamellæ; one set arising from the cortical tissue, absorbing the surrounding moisture and serving to transmit this humidity to the cells in which the spores are formed, being therefore the organs of nutrition; the others, remarkable for their white colour and opacity, terminating externally, introducing air into all parts of the Fungi and bringing it into contact with the sporigenous cells themselves. This communication of the external air with the internal lacunæ of the Fungus is much more evident in the Truffles and in certain other *Tuberaceæ*, than in the other hypogæous Fungi, where the lacunæ analogous to those of the Truffles, although filled with air, do not appear to communicate with the exterior.

The formation and structure of the spores have also been the objects of very interesting researches by Messrs. Tulasne. In all the true *Tuberaceæ*, the spores are developed freely in the cavities of the sporangia, or vesicular cells destined to produce them. They are limited in number, and not very variable, in each of these sporangia; more than eight are never formed in one vesicle, and in many species the maximum number is four.

These spores exhibit very varied forms, according to the genera and species in which they are observed, but are perfectly constant in the same species. This diversity however depends almost solely upon the structure of the external membrane or *epispore*, sometimes smooth, sometimes with points all over, or variously reticulated. Beneath this external, coloured and rather resisting membrane, is found a second integument, smooth, transparent, more or less thick, but strongly resisting chemical agents, and not only colourless in its natural state, but not coloured by the action of iodine, and easily separable from the external integument by various reagents. The simple cavity of this internal utricle of the spore is filled with oleaginous globules suspended in a liquid which is probably albuminous, and is coloured yellow or brown by iodine.

These reproductive bodies, although less simple in their structure than has been sometimes supposed, are still far from representing on a small scale the organization of the Truffle itself, as Turpin supposed; their structure is not more complicated than